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## (54) Thermal insulating panel

(57) A thermal insulating panel (5) comprises an envelope (6), of which at least a part thereof is of porous material, containing a block (7) of compacted microporous thermal insulating material. The panel (5) has external first and second surfaces (10,11), the first surface (10) being arranged to be subjected to an elevated temperature relative to the second surface (11). To prevent build-up of pressure within the envelope (6), vent means, such as one or more apertures (12 and 18) or notches (16), is provided communicating between the exterior of the panel (5) and an interfacial region (13) between the microporous insulating material (7) and the envelope (6) at the first surface (10) of the panel (5).

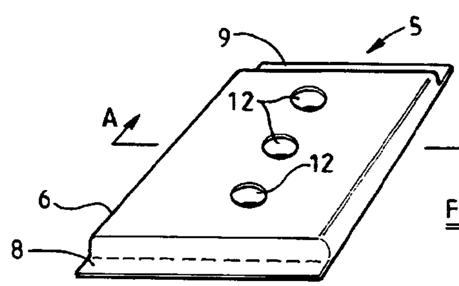


FIG 3

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This invention relates to a thermal insulating panel comprising an outer porous envelope containing a block of compacted microporous thermal insulating material.

The term 'microporous' is used herein to identify porous or cellular materials in which the ultimate size of the cells or voids is less than the mean free path of an air molecule at NTP, i.e. of the order of 100 nm or smaller. A material which is microporous in this sense will exhibit very low transfer of heat by air conduction (that is collisions between air molecules). Such microporous materials include aerogel, which is a gel in which the liquid phase has been replaced by a gaseous phase in such a way as to avoid the shrinkage which would occur if the gel was dried directly from a liquid. A substantially identical structure can be obtained by controlled precipitation from solution, the temperature and pH being controlled during precipitation to obtain an open lattice precipitate. Other equivalent open lattice structures include pyrogenic (fumed) and electrothermal types in which a substantial proportion of the particles have an ultimate particle size less than 100 nm. Any of these particulate materials, based for example on silica, alumina or other metal oxides, may be used to prepare a composition which is microporous as defined above.

The microporous insulating material typically comprises a dry particulate microporous material as defined hereinabove mixed with fibre or filament reinforcement, an opacifier such as titanium dioxide and, for high temperature use, a small quantity of alumina powder to resist shrinkage.

Handleable sheets and shaped constructions of microporous thermal insulating material are well known. A particularly advantageous form of construction, because of its cost-effective manufacturing technique, is a microporous insulating panel, as shown in cross-section in Figure 1 of the accompanying drawings, in the form of a compacted microporous insulating composition 1 which is enclosed by a woven glass envelope 2, there being some adhesion between the material of the envelope and the contained insulating material. Instead of using a woven glass material, which is inherently porous, for the envelope, other porous materials may also be used. If desired, part of the envelope may comprise non-porous material.

The porosity of the envelope is important during manufacture of the panel. Powdery microporous thermal insulating material is poured into the envelope, which is open at one edge. This edge is then sealed and pressure is applied to the exterior of the envelope to compact the insulating material, air being displaced through the porous material of the envelope. The extent of porosity of the envelope material affects the uniformity of density of the compacted insulating material and also affects what can be described as dustiness of the final product. In this latter regard, the woven glass cloth envelope material has very low permeability to the particulate materials constituting the microporous insulating material and this allows the panels to be manufactured with a substantially dust-free surface.

Thermally insulating panels constructed in this way have been found to be very acceptable for use in most applications. However, problems can be encountered when such a panel is applied to a warm surface.

It has been found that when the panel is applied against a warm surface swelling of the panel may occur, so that the panel is no longer flat and rigid but has the appearance of having been blown up like a balloon, as illustrated in the cross-section in Figure 2 of the accompanying drawings.

On investigating this phenomenon, it has been found that at the face of the panel applied to the warm surface 3, the compacted microporous insulating material 1 becomes separated from the material of the envelope 2 and gas pressure is generated in the space 4 between the envelope and the insulating material. The gas pressure results from whatever gas, such as air, constitutes the ambient atmosphere surrounding the panel.

We have found that the magnitude of the gas pressure in the space 4 depends upon the temperature of the surface 3, the temperature of the surroundings and the pressure surrounding the panel, according to the following relationship:

$$\frac{\text{Pressure inside panel}}{\text{Pressure outside panel}} \alpha \sqrt{\frac{\text{Temperature of surface}}{\text{Temperature of surroundings}}}$$

Hence, the higher the temperature of the surface 3, then the higher the pressure generated inside the space 4 and the greater the swelling of the panel when the envelope 2 is of very low porosity.

This swelling of the panel is undesirable as it may cause the panel structure to be ruptured and it may be difficult to build up layers of other materials against the panel.

Although the material of the envelope 2, such as woven glass fabric, is inherently porous in nature, particles of the microporous insulating material tend to block the pores and this prevents escape of air, or other gas, from the space 4 through the envelope 2 as the pressure in the space 4 builds up.

It is an object of the present invention to overcome or minimise this problem by providing a means to avoid build-up of gas pressure between the microporous insulating material and a surface of the envelope which is subject to a temperature which is higher than that to which another (for example opposite) surface of the envelope is subjected.

The present invention accordingly provides a thermal insulating panel comprising an envelope, of

which at least a part thereof is of porous material, containing a block of compacted microporous thermal insulating material, the panel having external first and second surfaces, the first surface being arranged to be subjected to an elevated temperature relative to the second surface, vent means being provided communicating between the exterior of the panel and an interfacial region between the microporous insulating material and the envelope at the first surface of the panel.

The vent means may comprise at least one aperture extending through the panel from an open aperture end at the exterior of the panel at least to an inside surface of the envelope at the interfacial region between the microporous insulating material and the envelope at the first surface of the panel. For convenience of manufacture, such at least one aperture may also extend through the envelope at the first surface of the panel to form a further open aperture end, in which case it may be preferred to provide cover means for the further open aperture end on the exterior of the envelope at the first surface of the panel to prevent ingress of unwanted material. Such unwanted material may, for example, comprise a cement, mortar or an adhesive used in connection with application of the panel with its first surface in contact with a component or structure whose surface is intended to be at the elevated temperature. If desired, cover means may also be provided on the exterior of the envelope at the first-mentioned open aperture end. Where two cover means are provided at least one should be air permeable.

The cover means may comprise a patch, for example of the same material composition as the envelope, secured to the exterior of the envelope by means of an adhesive.

The at least one aperture suitably extends from the exterior of the panel at the second surface thereof, the second surface being preferably opposite the first surface.

The vent means may alternatively comprise at least one notch provided in an edge region of the panel and communicating between the exterior of the panel and the interfacial region between the microporous thermal insulating material and the envelope at the first surface of the panel. Cover means may be provided for at least part of the or each notch, on the exterior of the envelope, at least in the region of the first surface of the panel, to prevent ingress of unwanted material as previously described in connection with the vent means in the form of one or more apertures. Where the cover means extends entirely over the notch, the cover means should be air permeable. The cover means may comprise a patch, for example of the same material composition as the envelope, secured to the exterior of the envelope by means of an adhesive.

In a further alternative, the vent means may comprise at least one aperture extending through the envelope at the first surface of the panel to the interfacial region between the microporous thermal insulating material and the envelope at the first surface of the panel.

If desired, a plurality of vent means may be provided.

At least part of the envelope requires to be made of porous material, such as a woven glass material which is inherently porous or materials such as plastics or metal foils formed with suitably sized apertures to render the material porous.

The porosity of the envelope material is suitably selected such that the material is permeable to gas, particularly air, whilst substantially preventing microporous insulating material from passing through it.

When the thermal insulating panel of the invention is applied to a structure for thermal insulation purposes, with the first surface in contact with a hot face of the structure, any tendency for gas pressure to build up at the interfacial region between the microporous insulating material and the envelope at the first surface is avoided by the provision of the vent means. The gas tending to produce such gas pressure may be air, or whatever ambient gas surrounds the panel.

The invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional view of a known thermal insulating panel;

Figure 2 is a cross-sectional view of a known thermal insulating panel following application against a warm surface;

Figure 3 is a perspective view of a thermal insulating panel according to the invention;

Figure 4 is a cross-sectional view along A-A of one embodiment of the panel of Figure 3;

Figure 5 is a cross-sectional view along A-A of an alternative embodiment of the panel of Figure 3;

Figure 6 is a perspective view of a further thermal insulating panel according to the invention;

Figure 7 is a cross-sectional view along B-B of the panel of Figure 6; and

Figure 8 is a perspective view of another thermal insulating panel according to the invention.

Referring to Figures 3, 4 and 5, a thermal insulating panel 5 is constructed by well-known techniques, for example as described in GB-A-1 350 661 and GB-A-1 247 674. Such a panel may also be prepared by the process described in UK Patent Application No. 9403564.9. The panel 5 comprises an envelope 6 of porous material, such as woven glass cloth, containing a block of compacted microporous thermal insulating material 7. The envelope 6 is sealed along opposite ends 8, 9 by means of stitching or by means of an adhesive. The panel 5 has an external first surface 10 opposite to which is an external second surface

11. The panel 5 is intended to be used for thermal insulation purposes with the first surface 10 in contact with a hot surface of a structure or component (not shown).

Vent means in the form of an aperture 12, for example of about 4 mm in diameter, is provided, the aperture communicating between the exterior of the panel and an interfacial region 13 between the microporous insulating material 7 and the envelope 6 at the first surface 10 of the panel. The aperture 12 passes through the envelope at the second surface 11 of the panel and extends either right up to the inside surface 14 of the envelope, at the first surface 10 of the panel, as shown in Figure 4, or completely through the envelope at the first surface 10 of the panel, as shown in Figure 5. With the arrangement shown in Figure 5, it may be preferred to provide a cover means 15 in the form of a patch of suitable material, such as woven glass cloth, secured to the exterior of the envelope by means of an adhesive and covering the aperture 12. Such a cover means 15 serves to prevent ingress of any unwanted material into the aperture 12 when the panel is secured to a structure by means which may involve adhesive material, cement or mortar, for example.

If desired, a plurality of apertures 12 may be provided as illustrated in Figure 3.

In a further thermal insulating panel, shown in Figures 6 and 7, this is constructed basically in the same manner as described above with reference to Figures 3 to 5, apart from the arrangement of the vent means. In Figures 6 and 7, parts substantially the same as those in Figures 3 to 5 are given the same reference numerals as in Figures 3 to 5. In the embodiment shown in Figures 6 and 7, instead of a vent means in the form of an aperture as shown by reference numeral 12 in Figures 3 to 5, a vent means in the form of a notch 16 is provided in a side edge of the panel 5. The notch 16 is suitably provided by means of a saw blade and extends from the exterior of the panel to the interfacial region 13 between the microporous insulating material and the envelope 6 at the first surface 10 of the panel.

A cover means 17 in the form of a patch of suitable material, such as woven glass cloth, may be secured to the exterior of the envelope by means of an adhesive to cover the notch 16 at a region thereof in the vicinity of the first surface 10 of the panel. Such a cover means 17 serves to prevent ingress of any unwanted material into the notch 16 when the panel is secured to a structure which may involve adhesive material, cement or mortar, for example.

A plurality of notches 16 may be provided, if desired as shown in Figure 6.

In a further thermal insulating panel, shown in Figure 8, this is constructed basically in the same manner as described above with reference to Figures 3 to 5, apart from the arrangement of the vent means. In Figure 8, parts substantially the same as those in Figures 3 to 5 are given the same reference numerals as in Figures 3 to 5. In the embodiment shown in Figure 8, instead of a vent means in the form of an aperture as shown by reference numeral 12 in Figures 3 to 5, a vent means 18 in the form of one or more apertures is provided extending substantially only through the envelope 6 at the first surface 10 of the panel to the interfacial region between the microporous thermal insulating material and the envelope 6 at the first surface 10 of the panel.

In application, the panels 5 of Figures 3 to 8 are applied as thermal insulation to a structure (not shown) with the first surface 10 in contact with a hot surface of the structure. In the absence of the aperture 12 of Figures 3 to 5, the notch 16 of Figures 6 and 7 or the aperture 18 of Figure 8, the compacted microporous thermal insulating material 7 would become separated from the material of the envelope 6 at the interfacial region 13 therebetween and gas pressure generated in the resulting space would cause swelling of the panel, as if blown up like a balloon, as previously explained and shown in Figure 2. The gas involved in such an effect can be air or whatever gas surrounds the panel in its particular application. The provision of the aperture 12, the notch 16 or the aperture 18 provides venting of gas and prevents any such gas pressure from being generated, thereby ensuring that the panel remains flat and undistorted when in contact with a hot surface.

## Claims

1. A thermal insulating panel comprising an envelope (6), of which at least a part thereof is of porous material, containing a block (7) of compacted microporous thermal insulating material, the panel having external first and second surfaces (10, 11), the first surface (10) being arranged to be subjected to an elevated temperature relative to the second surface (11), characterised in that vent means (12, 16, 18) is provided communicating between the exterior of the panel and an interfacial region (13) between the microporous insulating material (7) and the envelope (6) at the first surface (10) of the panel.

2. A thermal insulating panel as claimed in claim 1, characterised in that the vent means (12, 16, 18) comprises at least one aperture (12) extending through the panel from an open aperture end at the exterior of the panel at least to an inside surface of the envelope (6) at the interfacial region (13) between the microporous insulating material (7) and the envelope (6) at the first surface (10) of the panel.

3. A thermal insulating panel as claimed in claim 2, characterised in that the at least one aperture (12) extends through the envelope (6) at the first surface (10) of the panel to form a further open aperture end.

4. A thermal insulating panel as claimed in claim 3, characterised in that cover means (15) for the further open aperture end is provided on the exterior of the envelope (6) at the first surface (10) of the panel.

5. A thermal insulating panel as claimed in claim 4, characterised in that cover means (15) for the first-mentioned open aperture end is provided on the exterior of the envelope.

6. A thermal insulating panel as claimed in claim 4 or 5, characterised in that the cover means (15) is in the form of a patch secured to the exterior of the envelope (6) by means of an adhesive.

7. A thermal insulating panel as claimed in claim 6, characterised in that the patch is of the same material composition as the envelope (6).

8. A thermal insulating panel as claimed in any one of claims 2 to 7, characterised in that the at least one aperture (12) extends from the exterior of the panel at the second surface (11) thereof.

9. A thermal insulating panel as claimed in claim 8, characterised in that the second surface (11) is opposite the first surface (10).

10. A thermal insulating panel as claimed in claim 1, characterised in that the vent means comprises at least one notch (16) provided in an edge region of the panel and communicating between the exterior of the panel and the interfacial region (13) between the microporous thermal insulating material (7) and the envelope (6) at the first surface (10) of the panel.

11. A thermal insulating panel as claimed in claim 10, characterised in that cover means (17) is provided for at least part of the or each notch (16), on the exterior of the envelope (6), at least in the region of the first surface (10) of the panel.

12. A thermal insulating panel as claimed in claim 11, characterised in that the cover means (17) comprises a patch secured to the exterior of the envelope (6) by means of an adhesive.

13. A thermal insulating panel as claimed in claim 12, characterised in that the patch is of the same material composition as the envelope (6).

14. A thermal insulating panel as claimed in claim 1, characterised in that the vent means comprises at least one aperture (18) extending through the envelope (6) at the first surface (10) of the panel to the interfacial region (13) between the microporous thermal insulating material (7) and the envelope (6) at the first surface (10) of the panel.

15. A thermal insulating panel as claimed in any preceding claim, characterised in that a plurality of vent means (12, 16, 18) is provided.

16. A thermal insulating panel as claimed in any preceding claim, characterised in that the envelope (6) comprises a woven glass material.

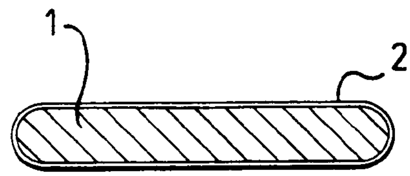


FIG 1

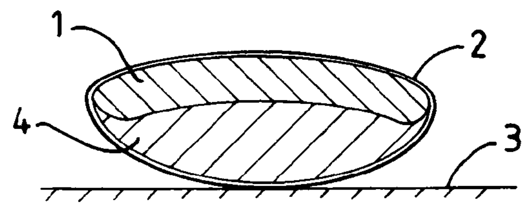


FIG 2

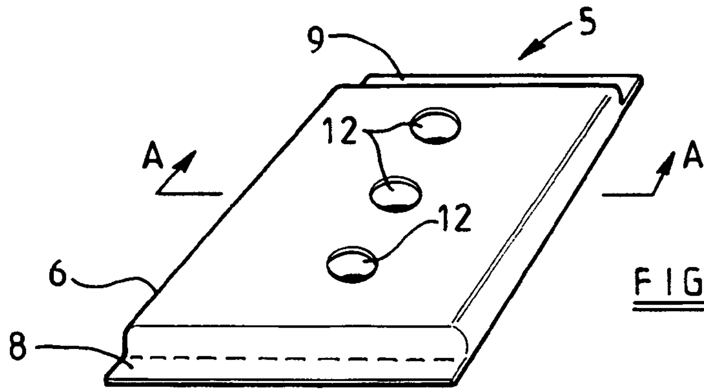


FIG 3

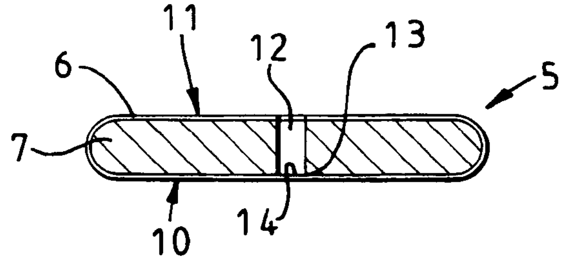


FIG 4

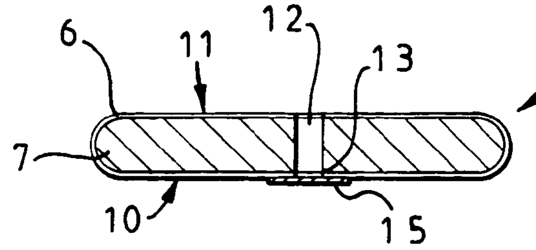


FIG 5

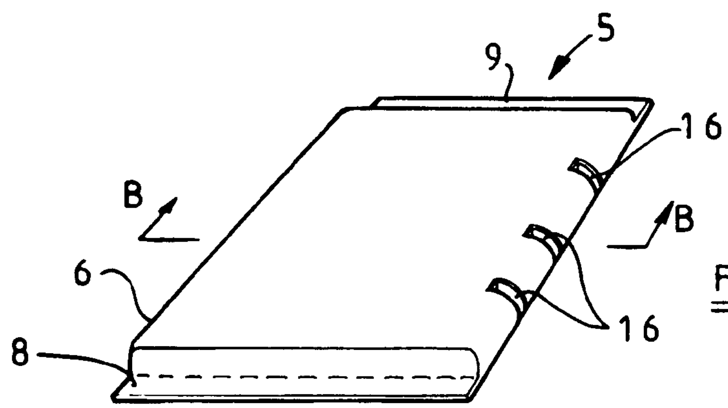


FIG 6

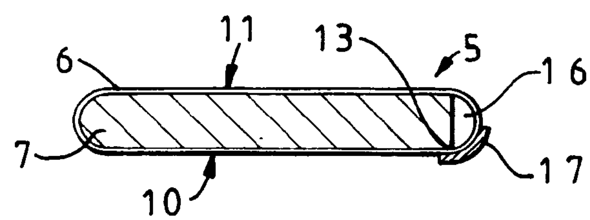


FIG 7

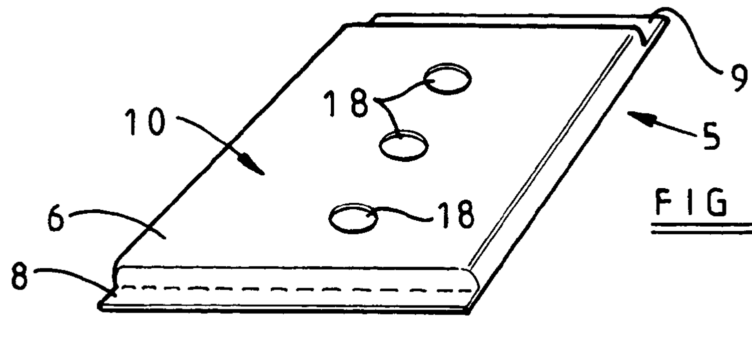


FIG 8

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 95 30 3816

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
|---|---|---|---|
| A | DE-U-88 03 533 (SIGRI) 5 May 1988<br>* the whole document *<br>--- | 1,2,9,15 | E04B1/80 |
| A | FR-A-2 096 170 (MICROPORE) 11 February 1972<br>* page 1, line 5 - page 2, line 24 *<br>--- | 1,16 | |
| A | DE-A-34 09 424 (THIELE ULRICH) 26 September 1985<br>* page 4, line 4 - line 20 *<br>* abstract; figures *<br>--- | 1,2,10 | |
| A | US-A-4 784 891 (SHICKEL ROBERT J) 15 November 1988<br>* abstract; figures *<br>--- | 1,2 | |
| A | DE-A-25 06 470 (UNITEX LTD) 14 August 1975<br>------ | | |

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
E04B
E04C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 13 September 1995 | Kriekoukis, S |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

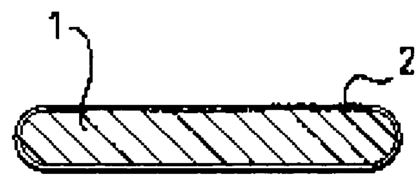


FIG 1

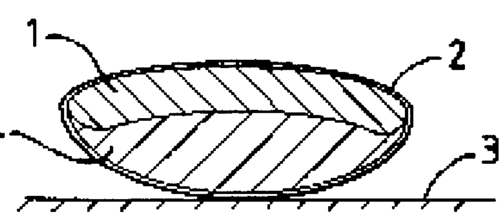


FIG 2

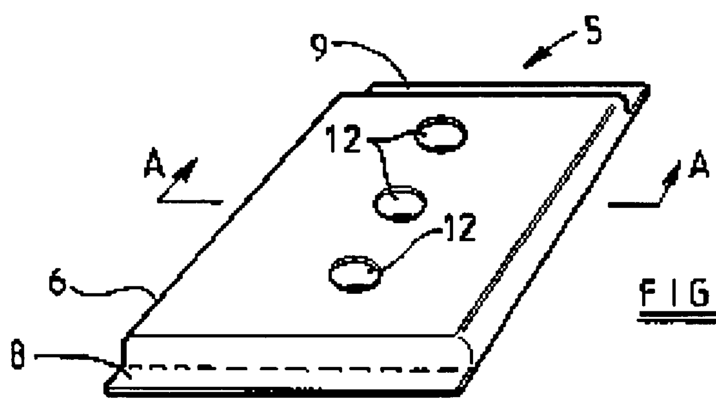


FIG 3

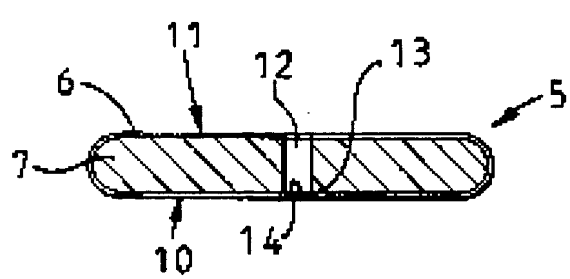


FIG 4

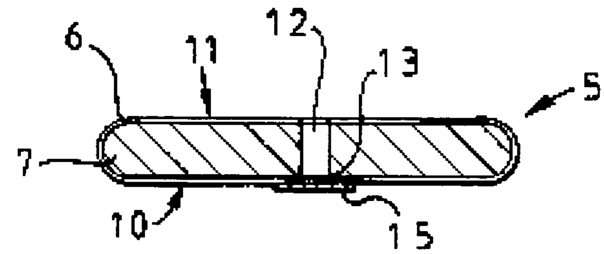


FIG 5

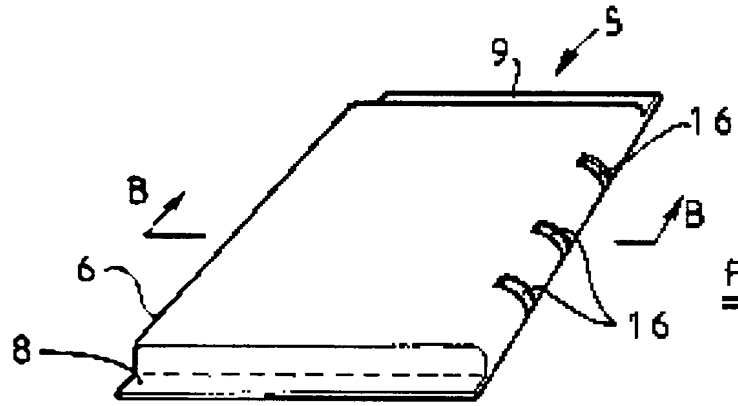


FIG 6

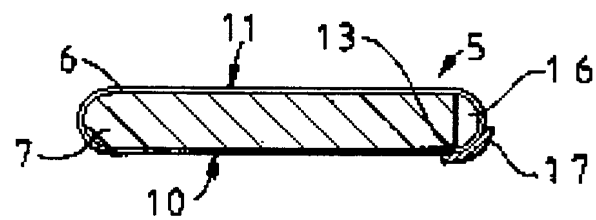


FIG 7

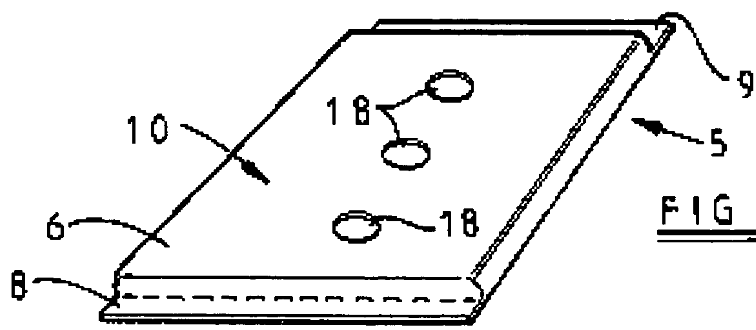


FIG 8